THE SUBMARINE BOAT: ITS PROMISES AND PERFORMANCES.

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THE submarine boat permits the imaginative to create for their satisfaction and delight all manner of weird and pleasing fancies. A few of its advocates find an ineffable pleasure in picturing the charming sensation of travelling under sea without any of the dangers, annoyances, and discomforts that attend propulsion upon the waves and billows. Some derive happiness from the comforting dream that, for war purposes, the submarine will constitute our coast line of defense, such people believing the boat to be as mobile and active as a shark, and able to discharge accurately torpedoes that will be as destructive as the most carefully prepared mine of high explosives. But the vast majority of those who are enthusiastic as to the future of this type of boat look upon the weird side of the picture. These morbid persons see something very terrifying in this unseen and uncanny foe, which, operating wholly under water and guided by human intelligence, can send fleets of battleships to the bottom without suffering harm themselves. And as this fancy is dwelt upon, even a distinguished naval architect is made to say: "This boat performs in a way that can best describe it as a fish of steel with the brains of a man."

Allied with the imaginative are the sentimental in advocating the utility of the submarine boat. In the desire to make war so destructive and terrible that the nations will not dare to provoke hostilities, the sentimental see in the submarine craft a weapon which may be developed to a degree that will make war impossible.

The strength of the visionists and humanitarians has been supplemented by the endorsement of some able and distinguished

naval officers, who believe that the submarine boat will play an important part in future wars, since such craft exercise a moral effect that will do much to disconcert and discourage the personnel of a blockading squadron. It is through the advocacy of these officers that the attention of the country has been concentrated upon this question. Good is sure to result from this agitation.

As a result of this discussion the seven Holland boats now under construction will be subjected to tests that will surely show the merits and weakness of this type of craft. The number that we are now building is sufficient for experimental purposes, and before the Congress will assemble again we shall have some positive information as to their value as fighting machines.

In regard to the favorable opinion expressed by several distinguished officers concerning submarines, Admiral O'Neil, the Chief of the Bureau of Ordnance of the Navy Department, who has had general charge of the Holland boat since she was turned over to the Government, declares:

"I recognize the fact that favorable comments have been made concerning the 'Holland,' by several eminent naval officers, for whose judgment I entertain the highest respect, but after a careful analysis of all the information that is obtainable concerning her, I am at a loss to understand upon what such opinions are based, as the 'Holland' has never shown the ability to do anything more than run at a slow speed on the surface and make submerged runs of short duration at much slower rate of speed, always, in carefully selected localities, and under most favorable conditions. This is the sum total of her performances, which I am unable to accept as sufficient evidence that such boats are useful and efficient instruments for naval purposes."

With many exceedingly aggressive forces arrayed in favor of the submarine, it can be expected that determined efforts will be made to construct more boats of this character. The majority of naval students and experts, however, are still agnostics upon the question, because they believe that there is nothing in the capabilities of the boat which have so far been demonstrated to justify its extended use. It is possible that the type may eventually be developed to a state of reliability and efficiency; but when the serious difficulties which must first be overcome are taken into consideration, it will be evident that that hope can be realized only after important improvements have been effected.

Nearly four hundred years have elapsed since a submarine craft was experimented with at Toledo, Spain, and it is possible

that submarine navigation was seriously attempted even earlier. For over one hundred and twenty-five years, the world has had a boat which could be submerged and made to rise to the surface, and which could also be made to run either as a surface or submarine boat. At this time, we have, therefore, nothing to learn as to the fact that men can live and work under water. It may also be admitted that the crew can remain below for many hours. We also know that the boats can run under water at a slow speed. The submarine torpedo-boat of to-day is, practically, of the same design as that of a century ago. The present one is more efficient simply by reason of the fact that we now possess a lighter storage battery and can secure better material of construction, and also because the machine tool is able to turn out motors and auxiliaries which are cheaper, lighter, more compact, more reliable and more efficient than could ever be manufactured before. The promises of the past are thus nearer becoming performances. And this improvement in material and tool work really represents all the progress which has been made in the submarine torpedo-boat during a hundred years of development and experiment. The advance has been, therefore, along engineering rather than naval architectural lines.

Undoubtedly, the most careful study of the history of submarine boat construction has been made by Carl Busley, a noted German Marine Engineer and Naval Architect, who has published a monograph upon the subject, which was originally read before the German Society of Naval Architects and Marine Engineers, Berlin, Germany, in 1900. He commences in this manner:

"Of all the branches of ship construction, the ignorant have devoted most of their energy to the designing of submarine boats. According to my researches from the year 1861, in the former Prussian and the present German navies, I have found not less than 181 different designs of submarine boats which have been submitted, whose designers were in all branches of business excepting that of ship construction. It is strange in searching over these papers to note that ministers, teachers, students, bank clerks, railroad employees and other people in the peaceful walks of life, as well as simple mechanics, have devoted their time to the designing of a death-dealing submarine machine, which, after particularly fantastic performances by diving, must sink at least six lines of battleships. The explanation for the great attention paid to the designing of submarine boats by landsmen and for the great interest which the public at large will always take in such apparatus, lies, no doubt, in the fascination of horrors. Furthermore, it is noticeable what little interest in construction of this kind has been taken by legitimate builders and de-

signers in the different shipyards of all countries in past years. Latterly, the navies of several countries have interested themselves in the question as to the outlook of the submarine boat in naval warfare; and, since then, the builders have taken a more earnest interest in the different questions, so that it is possible to tabulate the different qualities and properties which the modern submarine boat requires. Submarine vessels can be divided into two large groups: No. 1, actual submarine boats which are intended to be entirely submerged; No. 2, partially submerged boats which remain very close to the surface and from which only single parts, such as the look-out tower, project above. The older boats are mostly of the first class and the boats of modern construction are of the second class."

The inherent defects which confronted the inventors of a hundred years ago still exist in the submarine type. Broadly speaking, the craft is still without an eye to direct her movements. The compass on a submarine boat must, of necessity, be an unreliable instrument. As it must be placed near masses of iron or steel which are liable to be moved, there must be a constant change of directive force. When a torpedo is fired, when a spare one is placed in the tube, or when the conning tower hatch is put on, the compass must be affected. Extraneous influences, such as chain cables, vessels at anchor, or passing ships may cause a deflection of the compass.

In an electrically propelled boat, there is so much free magnetism flying about that the compass must be of little use. It is to be remembered that the standard compass in an ordinary steel ship stands on the bridge, or on a tripod high above the hull; but in the submarine boat, the compass is inside—within, so to speak, the very body of a magnet, with all sorts of consequent and inconsequent poles.

The French boats are probably superior to all others in their ability to navigate. If any reliance can be placed on newspaper accounts, the French have perfected the Periscope to such a degree that it is now a fairly reliable instrument for the purpose intended. It is claimed that with this instrument, no matter at what depth, the commander can secure an absolutely faithful and detailed image of all that is taking place on the surface. As the tube of the Periscope must be in length as many feet as the boat is submerged, and as its top rests on the surface while the boat is moving beneath the water, any floating object on the surface may break off the end of the tube. As a matter of fact, however, some form of the Periscope has been tried at intervals for a decade and has been discarded by experts after short use.

Practically, but little advance has been made in securing increased stability. There can be little or no longitudinal stability in any boat which is designed to dive like a porpoise. Transverse stability can be secured, but longitudinal cannot be gotten without making sacrifices which would seriously interfere with the boat's efficiency. The discharge of a torpedo would instantly be followed by the rise of the boat's bow. It is true that there are compensating tanks to make up for the weights removed by the discharge of the torpedo. But the torpedo is shot out almost instantly, while an appreciable time must be required to fill the compensating tanks, and so, of necessity, there must be a tendency for the vessel to stand on end. Practically, therefore, the torpedo must be fired when the submarine is at rest. Careful investigation fails to show that one torpedo was ever fired with accuracy while the boat and target were in motion. So far as the "Holland" is concerned, it has been officially stated:

"That her efficiency with respect to torpedo practice is practically unknown, as only two torpedoes have been launched from her, one of which failed to run, and the other was at a fixed and not at a moving target."

Much has been written about the speed of the vessel, and yet there is no evidence that any submarine boat has ever been able, on a submerged run, to secure a six-knot speed for three successive hours. Even on her official *surface* endurance trial, the "Holland" averaged only 5 2-3 knots speed. The friends of the submarine craft are very fond of quoting surface runs of their own boat, or the records made by a "submersible" boat, when recounting the advantages and performances of the submarine type. But the "submersible"—which cannot completely immerse itself, but only submerges its hull, leaving exposed a portion of the dome—is simply a special launch or vidette boat. In its invisibility, the submersible may be mistaken for a submarine. It is in the direction of the submersible boat that we can probably look for a powerful weapon, and we should keep our eyes open to that fact.

Some remarkable statements have been made as to the time required to submerge and raise this type of boat. In any boat where there is but little reserve buoyancy, care must of necessity be exercised in adding, removing or shifting weights. Therefore, in filling and blowing out the submerging tanks, which hold at least twelve tons of water, a considerable period of time must be required.

The work of filling boilers direct from the sea and "blowing down" is very familiar to marine engineers. This operation must be done gradually, otherwise there is serious danger of the sea and boiler-joints becoming ruptured. And the same precautions must be taken in filling and blowing down the submerging tanks of any submarine.

It is simply a mechanical impossibility for the "Holland" to be safely submerged to even a depth of ten feet in less than one minute. Of course, she can be sunk by an enemy or ill-disposed person in less time, but it is not the purpose of her designers to have her own crew perform this evolution. It is also possible, when the boat is practically awash, to submerge her to a few feet more in depth in a comparatively short time, but, when in that position, the wake of the boat might make her presence known, and the projectile from even a machine gun would sink her.

The performance of the "Holland" in diving has been carefully watched by others than her owners. In submerging her, it may be only a few seconds from the time the conning tower is dimly visible until that structure disappears. When the boat has to sink after a surface run, sufficient time should be allowed for the motor to cool, and for the boat to be cleared of the gases.

When the French Minister of Marine inspected the submarine boat "Gustave Zede" at Cherbourg in December last, it took nine minutes to submerge that craft.

It is all very well to talk about using the horizontal rudders for causing boats of the "Holland" type to dive and rise, but the fact that the submerging tanks have to be filled with 3,300 gallons of water before the horizontal rudders will act efficiently, shows that these rudders are practically inoperative near the surface.

As the modern submarine is a spindle filled with mechanical appliances, it is of importance to inquire as to the efficiency and installation of these machines. It is because these appliances are constantly giving trouble when subjected to official tests, that it can be asserted that the boats are still in an experimental state. It may, therefore, be well at this time to refer briefly to the character of the installation of the various motors and auxiliaries.

In using three distinct systems of mechanical energy, many of the submarine torpedo-boats have an inherent weakness. In the "Holland," a small boat of 75 tons, gasoline, electricity, and compressed air are used for different purposes.

Gasoline is extremely liable to explode. At least one of its products of combustion is extremely dangerous to life. It is very attenuated, and therefore a great searcher. If there is a defective joint, or pipe, or leaky valve, the gasoline will find it.

During the official speed endurance trial of the "Holland," after the armature of the motor burnt out, it became necessary to start the gas-engine without the assistance of the electric motor. To secure the requisite amount of air for insuring an explosion at the start, recourse was had to the reduced air-pressure in the pipes. It took at least twelve minutes to start the engine in this way. During the effort, there was a slight discharge of the gas into the hull from some improper working of the valve. Even from this small leakage, the machinist in charge became much distressed.

In a boat of the character of the "Holland," it must be difficult to keep the electric motors in a high state of efficiency. The compartment must of necessity be damp, and therefore drops of water are likely to fall on every part of the motors. Salt water is liable also to fall down the hatches and ventilators, thus menacing the dynamos and storage batteries.

The air flasks may be an element of danger, since they are charged to a pressure of 2,000 pounds. The explosion of any one of these tanks would destroy the vessel. There are reducing valves for regulating this pressure; but any careless, inexperienced, or evil-disposed person might wreck the boat or cause a serious casualty by tampering with the reducing valves. These valves are so exposed that it will not be a difficult matter to alter them by any one possessing even an elementary knowledge of marine engineering.

The gas-engine is so closely installed to both electric motors that it will be a very difficult matter to do any extensive overhauling or make important repairs. In fact, the three appliances are so bunched together that it will take at least several working days to line up the shafts of this little craft.

There are three sets of gearing. The use of gearing on board any ship is at least inadvisable, for, no matter how strong the hull is made, there must be in a seaway some working of the vessel, and the gear is likely to break if it does not become impaired.

The noise in the engine-room is a serious disadvantage. The gas-engine is subjected to shock rather than to steady pressure, and therefore the engine pounds heavily. As all three sets of

gearing are running continuously, there is considerable noise from that source.

Since the explosion of the gasoline is effected by a spark from an ignition storage battery, any accident to this battery would throw the gas engine out of operation. This may prove a serious weakness since the cells of the storage battery are in such an exposed position that they could be very easily impaired.

Despite these weaknesses of the "Holland," she possesses some value in her ability to possibly reach unseen the enemy's fleet, discharge her torpedo, and immediately disappear and get away. This invisibility can be almost entirely secured by the building of a semi-submerged boat, and since such a boat could have at least double the speed that could be given the submarine craft, her chances for getting in and away would be greatly increased.

Even though every existing type of submarine boat may thus have inherent weaknesses which prevent its being a practical fighting machine, yet it is the wish of every one connected with the Navy that development and improvement may take place.

Every nation that possesses or aspires to sea-power is only too anxious to adopt any new type of craft that may contribute to its naval strength. If the development of the submarine had made any substantial progress, it is to be presumed that the British Admiralty would have utilized this craft long before now. The British estimate of its usefulness may be measured by the manner in which her naval writers refer to the boat.

In the annual competition in 1900 for the prize of the Royal United Service Institution of Great Britain, the gold medallist wrote thus upon the matter; and the views of the author are practically those of the best informed officers of the Service:

"Submarine boats are a confession of weakness and by no means to be recommended for our own Navy, whatever foreigners may think about them. Both the Americans and Spaniards were in possession of boats of this class during the late war, but as neither attempted to make any use of them, we may perhaps be permitted to conclude that they did not think they were worth the trouble of transporting to the scene of action.

"Although a very large number of a variety of types have at different times been invented and experimented with, the results of their trials, though at the time often reported as eminently satisfactory, have never been such as to lead to their construction on any large scale. Their use, too, has been condemned for what now, perhaps, would be scoffed at as sentimental reasons. But it may be remembered that even Napoleon, who was not particularly troubled by

scruples of this kind, refused to employ the fairly successful boat invented by the American, Fulton, against the British fleet, while his admiral, Decres, remarked that such craft 'were only fit for Algerines and pirates.'

"France, however, has several in hand at present, probably more with a view of pleasing the fancy of the public than from the real expectation that they will be of any particular value to her Navy."

Despite the fact that the Naval Lords are still sceptics upon this question, the Admiralty has been compelled to yield to the demand of many laymen that submarines be constructed. Five boats have been ordered, the first of which should be delivered in the autumn. Upon this action the Admiralty report says:

"What the future value of these boats may be in naval warfare can only be a matter of conjecture. Experiments with these boats will assist the Admiralty in assessing their true value. The question of their employment must be studied in all its developments, and their mechanism carefully watched in this country."

The policy of England, therefore, has been to build as few as possible to satisfy clamor, and yet a number sufficiently large to determine their true worth.

It is in France that the submarine has the most friends, and yet the total cost of all the boats built, in process of construction and authorized by the "Budget" will only approximately reach $3,000,000.

France has only four submarine boats actually in commission. These are the "Gymnote," "Gustav Zede," "Morse" and "Narval." Three more boats, the "Français," "Algerien" and "Farfadet," are about completed, and are almost ready for their official tests. According to *Le Yacht*, a French marine periodical which ought to be an authority on the question, only the seven above mentioned will be ready to go into commission in the year 1901.

In addition to the seven boats that are either in commission or about ready for their official tests, fifteen other submarine boats have been authorized or are building at Toulon, Cherbourg and Rochefort. As the United States ought to have eight submarine boats in commission before the end of 1901 (since it is stated by the Holland Company that their boats will even be completed by May), we shall actually be in advance of France by the end of this year in the number of boats that we shall have afloat.

Two of the boats that are being constructed for the French Navy were paid for by popular subscription conducted by the *Matin* of Paris. Only twenty-three, therefore, have been authorized at all times by the French Admiralty. Is it not reasonable

to presume that, since the general public presented the nation with two of these boats, the Admiralty were compelled to recognize public sentiment, and that several other boats were authorized in response to this pressure.

The following résumé shows the actual condition of submarine boat construction in France at the present time. It will be observed that the cost per ton in France has never yet exceeded $1,100, although the Admiralty of that country demand a twelve-knot speed, and therefore a very large and costly installation of storage battery is required. In this country we are paying $1,500 per ton for a seven-knot boat, with a storage battery of less than one-third the power of the French type. May we not expect, therefore, when the construction of submarine boats is open to all competitors, that we can secure boats at less than two-thirds the price that we are now paying, since the storage battery is the most costly portion of the vessel?

Name.	Tonnage.	Ordered Built.	Laid Down.	Estimated Cost.
In commission:				
"Gymnote"	30			
"Gustave Zede"	266			
"Morse"	146			
"Narval"	106	June 1, 1898	Nov. 23, 1898	
About completed:				
"Français"	146	April 8, 1899	Oct. 3, 1899	$146,699.30
"Algerien"	146	April 8, 1899	Oct. 3, 1899	146,699.30
Under construction:				
"Sirene"	106	June 20, 1899	Aug. 28, 1900	119,177.50
"Triton"	106	June 20, 1899	Aug. 28, 1900	119,177.50
"Silure"	106	May 1, 1900		119,177.50
"Espadon"	106	May 1, 1900		119,177.50
"Farfadet"	185	Sept. 20, 1899	April 2, 1900	154,428.95
"Korrigan"	185	Sept. 27, 1899	April 23, 1900	154,428.95
"Gnome"	185	Sept. 27, 1899		154,428.95
"Lutin"	185	Sept. 27, 1899		154,428.95
Authorized by the Budget of 1901—				
Eight boats	106			Each 199,177.50

The Budget for 1902 provides for *three* boats of a *new* type. It would thus appear that not only is France dissatisfied with the performance of the boats now in commission, but it is also evident that she does not place too much reliance upon the design of those now in course of construction. Submarine boat construction, therefore, in France, cannot be said to have passed beyond the experimental stage.

The French Admiralty recognizes the fact that the best interests of the nation can be subserved by giving different inventors a chance to test their appliance. The motive power is, therefore, different in the various boats. In the "Narval" steam and elec-

tricity are the motors; in the "Morse" electricity alone is the propelling force.

The French Admiralty officials must have been somewhat sceptical themselves as to the military advantages of these boats, otherwise it would not have been necessary for any Parisian journal to appeal to the general public for funds to construct any such boats. No evidence can be found that a popular subscription was needed to build either a battleship, armored cruiser, protected cruiser, or torpedo boat; in the construction of these practical fighting machines, the French Admiralty officials required no spurring from the general populace. It is not to be wondered at that the naval officials at London, Berlin and St. Petersburg repose very little confidence in the military importance of any type of boat whose most enthusiastical endorsement comes from a general public that must of necessity be unacquainted with the essential features of an innovation in naval construction.

The German Admiralty, in view of the attitude of both France and the United States, has been giving particular attention to this subject. Early in March, 1901, it was officially stated by Admiral von Tirpitz, the Naval Secretary, that he still adhered to his unfavorable opinion regarding submarine boats, and that the Naval Department would not construct a single one.

In the course of a lecture delivered early this year at the Military Casino by an officer of the Austrian Navy, it was contended that there is thus far little prospect of the submarine boat playing an important part in naval warfare, and it was maintained that Austria-Hungary therefore does well to await the results of further experiments before incurring expense for such vessels.

Even the most earnest advocate of this type gives excellent reasons why we should wait before authorizing the building of more boats.

Admiral Hichborn says:

"No vessel was ever built yet that there was not something in a second boat that could be an improvement."

Mr. Creecy, the representative of the Holland Company, says:

"They (the shipbuilders) will build the boats according to our plans; but they say, 'We will not guarantee the success of those plans'; so this company takes all the risk."

If the shipbuilders hold such views about the craft, is it surprising that others are not convinced that the boat is a finished product and successful war appliance?

It is Constructor Lewis Nixon who asserts that the new boats will be an improvement upon the "Holland." If the trifling service performed by the "Holland" could suggest improvements so important in Mr. Nixon's judgment, why cannot we assume that, when eight of these boats are in commission, we shall be able to secure data which will permit us to design boats far superior to those already authorized?

For over eight years the Construction Board of the Navy Department has been carefully investigating the question, and it is its opinion that, before building any more boats, we should find out the capabilities of the seven that are now in the course of construction. As this Board is desirous of securing for the Navy every form of boat that possesses any military or strategic value, its members had a predilection to approve rather to condemn the submarine boat when the matter was first presented to them.

In 1892, the Board commenced to give careful consideration to the question of submarine boat construction. As a result of this investigation, the Congress authorized the construction of the "Plunger," a boat of the "Holland" type. This boat, after five years' work upon it, was abandoned as a hopeless failure by the Holland people, and now that company is building another to take its place. With the "Plunger" as a complete failure, and the "Holland" turning out less than a six-knot surface boat, the members of the Board are, naturally, a little more sceptical upon the question than they were even five years ago.

This Board has not been a conservative one, apprehensive of assuming responsibility, nor has it hesitated in adopting new appliances. It has awarded battleships to shipbuilding firms that have heretofore not even constructed cruisers. It has placed superposed turrets on the "Kearsarge," "Kentucky" and other battleships—an innovation that has not been attempted by any other naval power. Even in constructing submarine boats, it has taken a step in advance of any other nation, excepting France.

The Board of Construction has never imposed conditions upon the Holland Company, except such as were deemed reasonable by the builders themselves. The Board is much more desirous than any one else can possibly be of securing an efficient boat. It is not wedded to the belief that only one firm can construct them. Past experience convinces it that much is learned from official tests. The Board believes that when a spirited rivalry has been

created between the commanders and crews of the several boats, information of the greatest value will be secured. For this reason, it is well satisfied that no additional boats should be authorized until at least several months after the boats now in course of construction shall have been placed in commission.

In case the Congress should conclude to authorize the building of any additional boats, the recommendation of the Board of Construction that no special type be specified should be carried out. The Secretary of the Navy should even be given discretion to contract for such boats as, in his judgment, are likely to prove most efficient and best suitable for naval purposes.

From a military standpoint, the field of submarine boat construction should be made as large as possible. Particularly should we strive, at least during the experimental stage, to encourage a spirited rivalry between inventors of radically different types. At the present time, the Lake Submarine Boat Company is exceedingly desirous of having an opportunity to compete for any new boats that may be authorized. Judging from the success secured by the boats of this type constructed for commercial purposes, we can certainly expect that this company is as capable as any other to make good any promises or obligations assumed. The Navy Department should be in a position to pit designer against designer, as well as builder against builder.

It would be extremely advisable to prescribe that at least one of the boats should be submersible only to the extent of having her conning tower awash. The Board of Construction has carefully and judicially studied this question, and now the members are satisfied that progress and success in the construction of submarine craft can only be secured by carefully analyzing the data that may be gathered from future official tests and experiments. From these data, important conclusions will be drawn which will undoubtedly cause marked changes from the present specifications. It is reasonable to presume, therefore, that, when any additional boats are authorized, the Department will be justified in imposing higher requirements than have even heretofore been demanded.

There is no mystery about any of the mechanical features of the submarine boat. To submerge her it is only necessary to run water from the sea into tanks at the bottom of the boat. To bring her to the surface these tanks must be emptied, and to do this compressed air from the storage flask is used. To cause her

to run under water, there is a storage battery to supply the electric current for operating a motor which is geared to the propeller shaft. While under water, air is supplied to the crew for breathing purposes from the storage flasks.

Every operation for the navigation or propulsion of the boat can be effected by a commercial auxiliary, and these motors are of the most simple character. It is doubtful if a single important claim of any of the inventors would be sustained by an appellate court, in case any shipbuilding firm should care to utilize any apparently destructive appliance that is now installed on such boats.

Any shipbuilding plant that has constructed a torpedo boat will find it an easy matter to build a submarine, for the latter boat has comparatively more room for the installation of auxiliaries than the former. The hope of ultimate success for the submarine rests in the fact that, where there is a spirited and keen competition between inventors, there is sure to be progress in development. The submarine is not an expensive boat to build. A fleet of fifty could be built at the cost of a single battleship. To add ten of the best submarines to the Navy ought not to involve an expenditure of over one million dollars. Except so far as taking care that only a fair price is paid, the question of expense is of minor importance. If the boat has any military or strategic value, we should change our policy of ship construction, for nothing could justify the building of so many battleships if the submarine possessed even a portion of the advantages that her advocates claim.

In the indifference of naval officers to this question there is great danger. The boats are either valuable or they are worthless for military purposes. From the time that the Senate and House Naval Committees look with favor upon these boats, there will be a decreased construction of battleships; and the action of the Congress in striking out of the Naval Appropriation Bill of 1901 all authorization for battleships and cruisers can certainly, in part, be traced to the belief that the submarine possesses many of the qualities claimed by its advocates.

It is, therefore, high time that those who believe in the efficiency of the submarine should be compelled to make good a few of their promises. It is easy for them to tell of the vast amount of concentrated energy possessed by these boats, and of the ease with which this energy can be directed against an enemy. Con-

centrated energy, however, is usually a very awkward thing to deal with, even on a battleship. Many details as to its handling will have to be solved before it can be efficiently and quickly used in a submarine. To be able to fire one torpedo from a submarine boat, after hours and even days of preparation, is far from promising work; nor has the craft proved more satisfactory as regards stability, speed, and manœuvering qualities.

There need be no haste in deciding this question. As the boats are neither costly, large, nor intricate, they can be built in six months. It is even claimed, that a premium for speed construction would induce shipbuilders to construct a submarine in three months. There ought to be fifty firms in this country able to construct these boats in case of necessity.

All nations are capable of possessing this boat as soon as they wish; consequently, there must be very little practical advantage in experimenting for the benefit of others. The principles governing the design are so simple that no nation can seriously consider its own plans as secret.

If submarines possess any military or strategic value, the Navy Department should formulate general requirements as to what will be considered acceptable boats. Shipbuilders should be told the limit as to tonnage, the speed demanded, the period of submersion, the requirements as to navigation, and the tests as to torpedo discharge. These are the five problems that have not been solved satisfactorily. Encouragement should be given to every firm that will enter upon such construction. Premiums should be offered for every advance that will be made in the solution of any phase of the question.

The submarine boat problem is something more than the building of a few vessels of that type. It may not only mean a change in naval construction, but a revolution in naval tactics, since submarines cannot fight submarines.

However sincere the builders of submarines may be, these men must of necessity give *ex parte* testimony as to the worth of their own designs. Therefore, the Naval Construction Board and the Secretary of the Navy should be sustained in their contention that performances, and not promises, should be the factors in determining the advisability of building more of these boats, as well as the character and type of the craft best suited to our needs.

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